

## Section 8 Results of Laboratory Analysis

### 8.1 Artifact Analysis

The entire artifact assemblage is summarized in Table 11 below. All of the artifacts could relate to the mid-twentieth century. Two of the artifacts produced quite precise dates. The Regal Amber Brewing Co. beer bottle (Figure 242) from Test Excavation 18 and the Coca-Cola bottle (Figure 243) from Test Excavation 41 both date from 1942. The deposition of these artifacts probably happened contemporaneously with the fill episode and probably within a year of artifact manufacture. While these are quite modest artifacts they do support the evidence from historic maps (contrast the 1933 map, Figure 16 and the 1943 map Figure 19) and general knowledge that 1942/1943 saw an exponential explosion of human activity and land transformation in the vicinity of the Hickam Air Force Base vicinity of the HHCTCP Airport Section. Other artifacts (Figure 244) may date to this timeframe.

Table 11. Artifacts Encountered in the Airport Section Test Excavations

Test Excavation #	Description of Artifact	Comments
T-010, St. IIa, 26-30 cmbs	4 highly oxidized metal fragments, possibly nails	11.2 grams
T-018, 170 cmbs	Complete clear bottle for Amber Brewing Co., San Francisco, Calif.; embossed mark for the Oakland, Calif. factory of the Owens-Illinois Glass Co. [O-I] on base, with date code for 1942; this brewery was called the Regal Amber Brewing Co. from 1935 to 1954 (Tavern Trove 2012; SHA/BLM 2013)	18 cm high x 6 cm in diameter; cylindrical, 2-piece cup mold, crown top, made in an Automatic Bottle Machine, white Applied Color Label for brand name; embossed on body "NO DEPOSIT NO RETURN – NOT TO BE REFILLED"; embossed on base "20 [O-I mark] 2/ Duraglas"
T-019	Rail road spikes (2)	(Not collected)
T-029, St. Ic, 107-135 cmbs	2 small glass fragments	Less than 0.1 grams
T-030	2 cut bones	(addressed as midden below)
T-031	Glass, clear, fragments	Feature containing charcoal flecks and fragments of clear glass. Not collected
T-038, St. II, 240-270 cmbs	Rusted metal piece	13.9 grams

Test Excavation #	Description of Artifact	Comments
T-041, St. II, 138-143 cmbs	3 rusted metal fragments	3.5 grams
T-041, St. II, 138-143 cmbs	2 small metal fragments	0.3 grams
T-041, St. II, 138-143 cmbs	Clear bottle, small body fragment	0.1 grams
T-041	Brown bottle, lip and neck fragment	8.75 cm long, 2-piece mold, exterior threads on lip, made in an Automatic Bottle Machine
T-041	Green hobble-skirt Coca-Cola bottle, neck to base fragment; embossed Owens-Illinois Glass Co. date mark on heel for 1942 (SHA/BLM 2013)	Cylindrical, fragment 8.6 cm high and 5.5 in diameter;
T-041	Wire Nail	11 cm long; wire nails were made after 1890
T-043, St. II, 289-305 cmbs	Clear bottle, small body fragment	0.3 grams

All terminology used to describe bottle traits and all bottle dating information used in this table was taken from the Society of Historic Archaeology, Bureau of Land Management "Historic Glass Bottle Identification and Information Website" (SHA/BLM 2013).

In this table, only two artifacts can be dated to a narrow manufacturing time, a Regal Amber Brewing Co., San Francisco beer bottle (Figure 242) and a Coca-Cola soda bottle (Figure 243). The glass for both bottles was made by the Owens-Illinois Glass Co. This glass manufacturing company marked most of their bottles with a (2 mm) embossed date code, a single-or double-digit number to the right of the Owens-Illinois mark (O and an I in a circle and a diamond) on the base of the beer bottle and the number "19" to the left of the Owens-Illinois mark with the number "42" to the right. Both bottles were manufactured in 1942, and were likely discarded within 5 years of their use date (Lockhart 2000:18). Typically Coca-Cola bottles manufactured in the Territory of Hawaii have "TH" marked on the base. The absence of the TH marking also indicates the Coca-Cola bottles were manufactured on the mainland and shipped to Hawai'i.



Figure 242. Regal Amber Brewing Co. Beer bottle (dating to 1942) from Test Excavation 18



Figure 243. Coca-Cola bottle (dating to 1942) from Test Excavation 41



Figure 244. bottle neck and wire nail from Test Excavation 41

## 8.2 Faunal Analysis

The results of faunal analysis are presented in Table 12 and are discussed below for each Test Excavation producing faunal finds. Summary remarks follow.

### 8.2.1 Test Excavation 1

Test Excavation 1, Stratum 1g, yielded 1 upper valve of a medium sized *Chama iostoma* rock oyster weighing 33.2 grams (the specific shell is shown in Figure 245). *Chama iostoma* were used as raw material for manufacture in traditional Hawaiian society (most famously for *lei niho palaoa* ornaments) but were probably most commonly collected as food. Titcomb (1979:350) writes of elderly women diving for these in Pearl Harbor and prizing their rich flavor. This shell would appear to be the result of human discard.



Figure 245. *Chama iostoma* rock oyster shell

### 8.2.2 Test Excavation 6

Test Excavation 6, Stratum II, (162-175 cmbs) yielded very small quantities of (< 0.1 gram) of sea urchin spine (cf. *Echinometra mathaei*) and (< 0.1 gram) of unidentifiable marine shell fragments. These were all on the order of 1 mm to 2 mm in length and highly fragmented. These marine invertebrate fragments are not regarded as midden, or the likely result of human patterns of discard, due to the very small quantity, the very small size of the fragments and the apparent composition. These may have ended up in the deposit as a result of natural processes (birds, tsunami, hurricane, pyroclastic events blasting up through shallow reefs, etc.).

### 8.2.3 Test Excavation 10

Test Excavation 10, Stratum IIa, (26-30 cmbs) yielded two fragments of bivalvia one of which appears to be *Pinctada radiata* (1.3 g) and the other is unidentified bivalvia (0.7 g). These may well have resulted from a pattern of consumption (hence midden). Four highly oxidized metal fragments (most likely iron or steel nails) were also recovered from this provenience.

Table 12. Airport Faunal Remains

Taxa	Provenience																		
	Test Excavation	1	6*	10	18*	21*	27*	30	30	33	34	35A*	38*	38	39	41*	43*	44	Total
	Stratum	Ig	II	IIa	II	II	II	Ib	Pipe fill	??	II	IIa	Ic	II		II	II	Ic	
	Depth cmbs		162-175	26-30	240	110-120	229-249	40	75	45	49-126	145-173	245-255	240-270	167-187	138-143	289-305	60-138	
Gastropoda							< 0.1 g incl <i>Turbo</i> & <i>Hipponix</i>							7.6 g incl. <i>Melampus</i> sp., <i>Nerita picea</i> , <i>Turbo sandwicensis</i> , <i>Trochus intextus</i> , <i>Hipponix</i> sp.		1.2 g incl. <i>Turbo sandwicensis</i>	11.0 g incl. <i>Cerithium</i> sp. <i>Turbo sandwicensis</i> , <i>Trochus intextus</i>	<i>Prodotia ignia</i> 11.3 g	33.2 g
Bivalvia		1 <i>Chama iostoma</i> valve 33.2 g		2 fragments: <i>Pinctada radiata</i> 1.3 g & unid. bivalvia 0.7 g	< 0.1 g unid. bivalvia	< 0.1 g unid. bivalvia	< 0.1 g unid. bivalvia					< 0.1 g incl. <i>Brachidontes crebristriatus</i>	<0.1 g incl. <i>Brachidontes crebristriatus</i>	0.8 g incl. <i>Brachidontes crebristriatus</i> and <i>Tellina palatum</i>	< 0.1 g <i>Brachidontes crebristriatus</i>	0.3 <i>Brachidontes crebristriatus</i>		<i>Chama fibula</i> 82.9 g, <i>Arcidae barbatia</i> 11.1 g	131.2
Unidentifiable/ Misc. marine shell			< 0.1 g			< 0.1 g	< 0.1 g					< 0.1 g	< 0.1 g			X			< 0.5 g
Echinoderm (sea urchin spine)			< 0.1 g <i>Echinometra mathaei</i>										<0.1 g <i>Echinometra mathaei</i>	<0.1 g <i>Diadema paucispina</i>					< 0.3 g
Crustacea (crab claw)													<0.1 g						< 0.1 g
Fish											< 0.1 g			0.6 g	1.5 g				2.1 g
Pig									4.8 g										4.8 g
Sheep/goat								6.1 g											6.1 g
Cow										31.3 g									31.3 g

\*Regarded as non-midden

#### 8.2.4 Test Excavation 18

Test Excavation 18, Stratum III, (240 cmbs) yielded < 0.1 gram of fragmentary unidentified bivalvia. This may not be midden due to the very small quantity and the very small size of the fragments.

#### 8.2.5 Test Excavation 21

Test Excavation 21, Stratum III, (110-120 cmbs) yielded < 0.1 gram of fragmentary unidentified bivalvia. This is not regarded as midden due to the very small quantity, the very small size of the fragments and the apparent composition.

#### 8.2.6 Test Excavation 27

Test Excavation 27, Stratum III (229-249 cmbs) included < 0.1 g of fragmentary marine gastropods (*Turbo sandwicensis* & *Hipponix* sp.) and < 0.1 g of fragmentary unidentified bivalvia. This is not regarded as midden due to the very small quantity, the very small size of the fragments and the apparent composition.

#### 8.2.7 Test Excavation 30

Test Excavation 30, Stratum Ib, at 40 cmbs yielded a 6.1 g portion of a goat/sheep (*Orvis* sp. / *Aries* sp.) femur that appears to have been cut with a metal blade. Hence this was clearly post-Contact midden.

Test Excavation 30, Stratum "Pipe fill", at 40 cmbs yielded a 4.8 g portion of a pig (*Sus scrofa*) rib that appears to have been cut with a metal blade. Hence this was clearly post-Contact midden.

#### 8.2.8 Test Excavation 33

Test Excavation 33 (45 cmbs) yielded a 31.3 g portion of a cow (*Bos taurus*) rib that appears to have been cut with a metal blade. Hence this was clearly post-Contact midden.

#### 8.2.9 Test Excavation 34

Test Excavation 34, Stratum II (49-126 cm) yielded a small unidentifiable fish bone (< 0.1 g).

#### 8.2.10 Test Excavation 35A

Test excavation 35A, Stratum IIa (145-173 cmbs) yielded < 0.1 g of fragmentary mollusk remains including *Brachidontes crebristriatus*. This may not be midden due to the very small quantity and the very small size of the fragments.

#### 8.2.11 Test Excavation 38

Test Excavation 38 Stratum Ic (245-255 cmbs) yielded very small quantities (< 0.1 g) of fragmentary bivalvia including *Brachidontes crebristriatus*, unidentified mollusk, sea urchin (cf. *Echinometra mathaei*) and crab claw. This is not regarded as midden due to the very small quantity, the very small size of the fragments and the apparent composition (including such taxa as *Hipponix* and *Melampus* sp. believed too small as to be worth the effort of collection).

Test Excavation 38 Stratum II (259-269 cmbs) yielded a relative abundance of 8.7 g of marine shell including *Melampus* sp., *Nerita picea*, *Turbo sandwicensis*, *Trochus intextus*, *Hipponix* sp., *Brachidontes crebristriatus*, *Tellina palatum* and *Diadema paucispina* sea urchin and a relative abundance of 0.6 g of fish bone (none could be identified further). This appears to include some midden reflecting a traditional Hawaiian consumption pattern but the midden density is not indicative of substantial habitation. This deep (259-269 cmbs) Stratum II sediment sample that yielded the midden signature was actually collected from below the water table and appear to have been highly disturbed and may indeed be fill. It would not be surprising if the fill came from the immediate area which was a clearly a rich cultural landscape and much of the fill would thus be expected to have a midden signature. We believe the fill here has midden in it.

#### 8.2.12 Test Excavation 39

Test excavation 39 (167-187 cmbs) included < 0.1 g *Brachidontes crebristriatus* and a particularly large fish vertebrae centrum (1.5 g).

#### 8.2.13 Test Excavation 41

Test Excavation 41 yielded 1.5 grams of marine shell midden including *Turbo sandwicensis* and *Brachidontes crebristriatus*. Given the context including charcoal this appears to be midden reflecting a traditional Hawaiian consumption pattern however the presence of rusted metal pieces in this provenience suggests post-Contact consumption.

#### 8.2.14 Test Excavation 43

Test Excavation 43 yielded a relative abundance of 11.0 g of highly fragmentary marine shell midden including *Cerithium* sp. *Turbo sandwicensis*, *Trochus intextus*. Despite the relative abundance of marine shell and the typical midden species identified, the small size, highly fragmentary nature and relatively large percentage of unidentifiable species raises a question as to whether this represents midden or not.

#### 8.2.15 Test Excavation 44

Test Excavation 44 Stratum Ic (a crushed coral fill layer) yielded three relatively large, relatively uncommon marine shells: the gastropod *Prodota ignia* (11.3 g) and the bivalves *Chama fibula* (82.9 g) and *Arcidae barbatia* (11.1 g). Stratum Ic was identified as a 173 cm thick fill layer of silty fine sand. It is probable that these shells were deliberately collected for consumption (and would hence be midden); however, their context within the imported fill layer clearly indicates that these shells are not archaeologically significant.

#### 8.2.16 Summary Remarks Regarding the Airport Section Midden

The faunal assemblage recovered in the course of the 47 Airport Section excavations was notably limited. No bird bone was identified. The mammal assemblage was limited to one identification each of pig, sheep/goat and cow all of which was clearly saw-cut with a metal blade indicating post-Contact (likely twentieth century) consumption. Less than 2.2 grams of fish bone was identified of which some 1.5 grams was accounted for by a single large fish vertebrae centrum. No fish species identification was possible on these fragmentary remains.

Five of the faunal fractions were on the order of 0.1 gram of marine invertebrates. While it is difficult to rule out that these were the result of traditional Hawaiian consumption patterns (midden deposition) it appears these were naturally deposited - possibly including deposition in the course of the phreatomagmatic eruption of the post-erosional Makalapa, Āliamanu and Āliapaʻakai vents through shallow reefs with invertebrate faunal remains swept up in the pyroclastic events, and/or tsunami or hurricane deposition. This is suggested by the small size (often < 3 mm) and highly fragmentary nature of the marine invertebrate remains as well as the composition (including such taxa as *Hipponix* and *Melampus* sp. appear too small as to be worth the effort of collection).

Only the post-contact saw-cut mammal bone (T-030 and T-033) and the faunal fractions from T-001, T-010, T-038 and T-039 and T-048 are suggested as likely to represent patterns of discard of food scraps or midden.

The posited midden assemblages in T-038 and T-039 are typical of shallow in-shore collection patterns with shallow relatively calm silty/sandy environments suggested by the *Turbo sandwicensis* and *Trochus intextus*, and intertidal rocky environments suggested by the *Brachidontes crebristriatus*.

The fishbone would be consistent with shallow, close-to-shore, reef species.

The general paucity of the faunal assemblage is striking and supports the absence of LCAs in the vicinity in indicating very limited traditional Hawaiian habitation in the vicinity.

## 8.3 Pollen Analysis

Results of pollen analysis from samples collected from this project were reported in *Pollen Analysis of Samples From the Honolulu High-Capacity Transit Corridor Project, Honolulu, Hawai'i* by Linda Scott Cummings presented in full in Appendix F. An overview of prior palynological studies in the vicinity is presented here followed by a summary of the pollen results from the Airport Section study area.

### 8.3.1 Overview of Prior Pollen Studies in the Vicinity

A statement of caution is needed as pollen studies by their nature are detailed and nuanced. Only a broad-brush overview is attempted here and the reader is referred to the studies themselves for details. The geographic relationship of prior pollen studies to the present pollen sample areas is presented in a contemporary aerial photograph (Figure 246) and also on a 1933 map (Figure 247) that depicts the geographic relationship of prior pollen studies to former fishponds as well as the present pollen sample areas.

#### Wickler Athens and Ward 1991

The International Archaeological Research Institute, Inc. (IARII) carried out palynological studies in association with a Fort Shafter Flats sewer line project. Seven pollen samples were taken from a Profile 1 area and six from a Profile 10 area. At least 84 species or types belonging to 49 families are represented (Wickler et al. 1991:37). Curiously given this diversity only one



Figure 246. Aerial photograph showing relationship of prior pollen study areas to the present pollen sampling locations

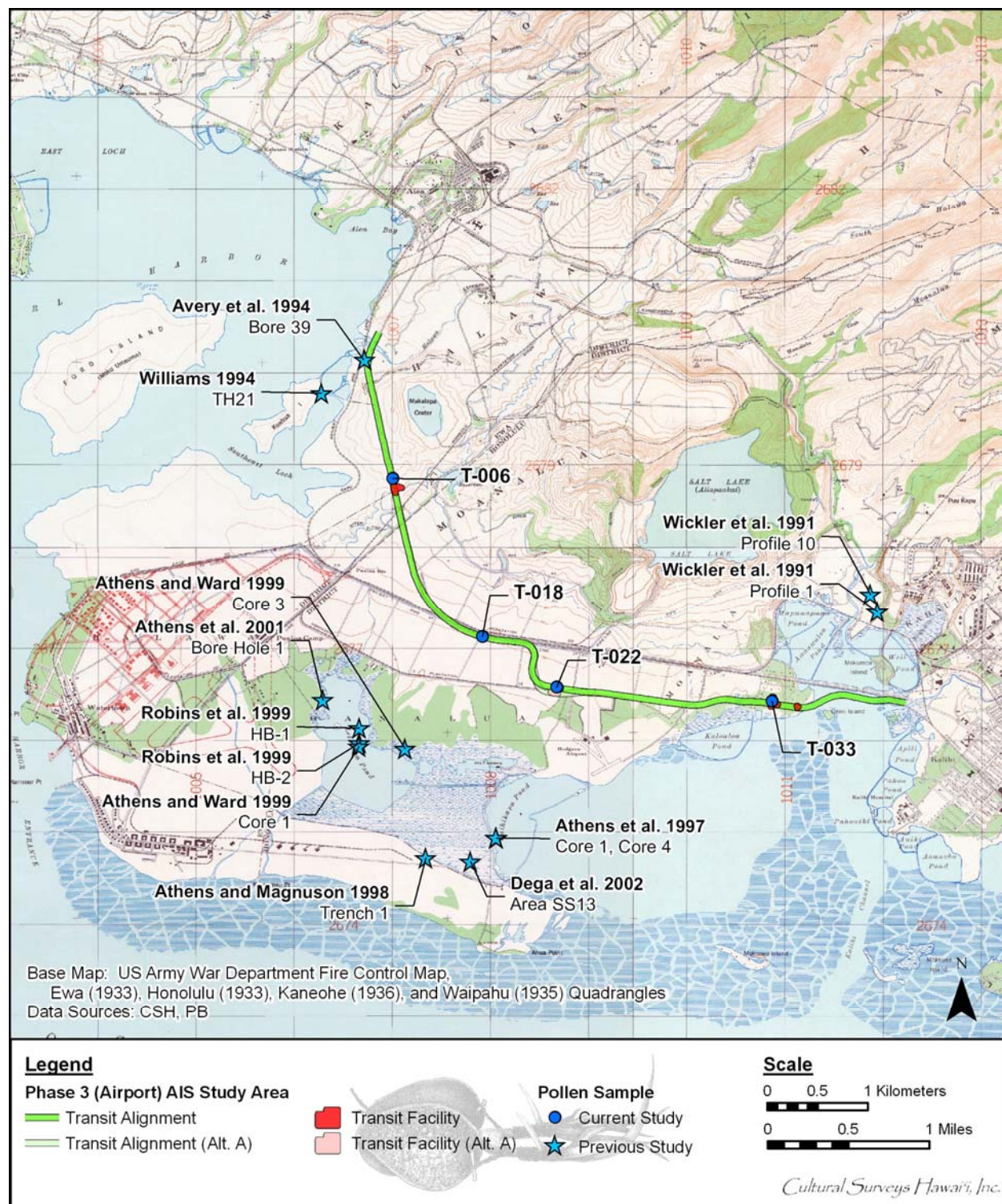


Figure 247. U.S. Army 1933 map showing relationship of prior pollen study areas to former fishponds and the present pollen sampling locations

Polynesian introduced species was documented (*Aleurites moluccana*, *kukui*). The study concludes:

...one conclusion is firm: the picture of a lowland *Pritchardia* (loulou) forest with a high diversity of dryland to mesic forest types offers a new level of understanding of the pre-contact natural lowland vegetation, very different from the vegetation seen today or even during the period represented by Pollen Zone A around A.D. 768-997. (Wickler et al. 1991:51)

In the oldest sediments *Pritchardia* pollen remains quite constant accounting for 27% to 28% of the pollen but by the A.D. 768-997 sample it drops to 2%.

#### **Avery, Brennan, Denham Kennedy and Ward 1994**

Archaeological Consultants of Hawaii, Inc. carried out palynological analyses as part of archaeological monitoring of an electric utility line project along Kamehameha Highway. The pollen data comes from a locale on the west (*makai*) side of the highway approximately 210 m south of the mouth of Hālawā Stream. Seven pollen samples were analyzed from a single borehole (Bore Hole # 39). While the results reported offer great time-depth going back nearly 4,000 years they somewhat lack specificity in that only the top sample (Relating to a radiocarbon date reported as A.D. 890-1294). The indicated trend (Avery et al. 1994:50) is presented in Table 13 below:

The study posits that while there was a “pre-Polynesian, gradual, decline in the *Pritchardia* record, it is certain that around, or shortly after, AD 890-1294 there was a catastrophic decline in the palm forest.” (Avery et al. 1994:55-56)

Table 13. Inferences from Pollen Study at the Mouth of Hālawā Stream (Avery et al. 1994:50)

<b>Zones of Pollen Record</b>	<b>Timeframe indicated from 14C</b>	<b>Characterization</b>
“Zone B”	[Relating to R1 reported date of A.D. 890-1294]	“..exhibited a dramatic increase in the presence of sedges and grasses, perhaps representing the development of marshy conditions locally, and of open environments inland, respectively.”
“Zone A2”	4,000 to 1,700 BP	“...essentially similar to A1, although there was a marked increase in the presence of pteridophytes which suggested a more open forest cover.”
“Zone A1	4,000 BP	“Dry-mesic forest, trees and shrubs... dominated by <i>loulou</i> ( <i>Pritchardia</i> sp.) pollen.”

### Williams 1994

Ogden Environmental and Energy Services Co. Inc. carried out palynological analysis in the course of their subsurface archaeological investigations in support of subsurface fuel investigations in the vicinity of the former Kunana Fishpond in the area just 100 m northeast of Magazine Loch of the Pearl Harbor Naval Base. Five pollen samples were analyzed from one auger core. There was a problem of modern (*Prosopis pallida*, *kiawe*) pollen contamination in pre-Contact strata. (Williams 1994: Appendix:2) The indicated pattern is of an abundance of Poaceae grass pollen in pre- or early Polynesian times (under an overlying C14 date of AD 372-796) Later (circa AD 974-1435 and 1298-1428) the pollen of shrubs and trees increases. This is somewhat counter-intuitive as the general trend is understood as forest changing to grass land in response to human settlement but is explained as clearing of Poaceae grasses from around the fishpond during fishpond construction and use (Williams 1994: Appendix:3). In the most recent sample (post-dating AD 1307-1668) indicates a change with “a much larger Poaceae pollen frequency [which] suggests that at this time the pond was filling in with vegetation including primarily grasses, and may or may not have been used as an active fishpond.” (Williams 1994: Appendix:3).

### Athens, Ward and Tomonari-Tuggle 1997

The International Archaeological Research Institute, Inc. (IARII) carried out a data recovery program for a Terminal Radar Approach Control (TRACON) expansion project at the west end of Honolulu International Airport within what was then Hickam Air Force Base (now a part of Joint Base Pearl Harbor Hickam or JBPHH). The data recovery program was undertaken to mitigate possible adverse impacts to the former Ka'ihikapu Fishpond (SIHP 50-80-13-0081). This data recovery included pollen analysis from two cores. In both cores “the profile appears to show inverted stratigraphy” (Athens et al. 1997:40) with native forest in the upper sample including *Pritchardia (loulu)*, *Kanaloa kahoowawensis*, *Acacia koa (koa)*, etc., and exotic introductions (*Batis maritima* or pickleweed, *Casuarina equisetifolia* or ironwood, *Prosopis pallida* or *kiawe*) in the lower sample.

Three Polynesian introduced species were detected: *Aleurites moluccana (kukui)*, *Cocos nucifera (niu or coconut)* and *Cordyline fruticosa (ti or kī)*. The authors reasonably conclude (Athens et al. 1997:42) that the upper sediments consist of fill (with relatively older pollen) that was superimposed on sediments that had been exposed to modern pollen types. It seems probable that the fill was procured from a neighboring locale but we really do not know. Because of the inversions and the fact that the pollen is not “in situ”, inferences are limited.

### Athens and Magnuson 1998

The International Archaeological Research Institute, Inc. (IARII) carried out an archaeological subsurface survey in support of a low level wind shear alert system relocation project within the south central portion of what was then Hickam Air Force Base (now a part of JBPHH) near the former Loko Ka'ihikapu Fishpond. Two samples from Trench 1 were analyzed. Disturbance or mixing was indicated in both samples (Athens and Magnuson 1998:17). Both samples may be historic (Athens and Magnuson 1998 :iii).

### Athens and Ward 1999

The International Archaeological Research Institute, Inc. (IARII) carried out paleoenvironmental coring at the former *loko* Lelepaua fishpond approximately 1.3 km southwest of the Airport alignment. Two cores were recovered. Fishpond sediments were not documented and “both cores contained inverted stratigraphy, with possibly intact (undisturbed) historic-period deposits overlain by sediments apparently pertaining to the prehistoric Polynesian period.” (Athens and Ward 1999:iii) The overlaying sediments (including the older pollen) were interpreted as fill.

The authors concluded that an earlier pre-Contact period:

is characterized by a mixed dry lowland forest community possibly dominated by *Pritchardia* palms with common *Chamaesyce*, *Dodonaea viscosa*, *Kanaloa kahoolawensis*, and with *Cibotium* and several other ferns. The late prehistoric period is characterized by a decline in the frequency of native taxa, higher counts of cheno-ams and grass, and the presence of Polynesian introductions (*Aleurites* and *Coco*). (Athens and Ward 1999:iii)

### Robbins, Clark and Allen 1999

Ogden Environmental and Energy Services Co. Inc. documented palynological analysis in the course of their archaeological monitoring and sampling during excavations for an AMC (Air Mobility Command) Ramp Lighting project in the central portion of the former Hickam Air Force Base (now a part of JBPHH) within what appears to be the former location of Lelepaua Fishpond. Four sediment samples were analyzed (one from Hole Boring-1 and three from Hole Boring-2).

The study notes:

Approximately 26 endemic plants (trees, shrubs, and herbs) are represented in the identified pollen from the samples. Of these, eleven are trees that include eight identified genera (*Acacia*, *Anlidesma*, *Bobea*, *Clermontia*, *Myrsine*, *Eugenia*, *Pritchardia*, and *Psycholria*), and three identified families (Myrtaceae, Araliaceae and Xanthoxylum). An increase in *Pritchardia* pollen (the endemic *Io'ulu* palm) from Layer VIII to Layer Vc was noted in the samples. The endemic shrubs are represented by eight identified genera, including *Broussaisia*, *Euphorbia*, *Erythrina*, *Vida*, *Hedyolis*, *Labordia*, *Scaevola*, and *Solanum*. Herbaceous endemics are represented by five genera, including *Bonamia*, *Schiedea*-type, *Lepidium*, *Cuscula*, and *Viola*, and two identified families (Apiaceae and Asteraceae).

Five Polynesian introduced plants are represented in the identified pollen, including two trees and two shrubs and a member of the family Liliaceae. Pollen identified as coconut (*Cocos nucifera*) was recovered from Layer VIII, and pollen grains from the family Myrtaceae (Myrtle family) were found in all of the samples. One of the shrubs, identified as a member of the Fabaceae family (legume or pea family) was also represented in all of the submitted samples. Pollen identified as a type similar to *Piper methysticum*, or *awa*, was recovered

from Layer VIIg. Layer Vc was the only sample containing ti (*Cordyline* spp., kī), a member of the Liliaceae family. (Robbins et al. 1999:39)

The study concludes (Robbins et al. 1999:42) :

The results of the pollen analysis tend to support the radiocarbon date from Layer VITI. The presence in this layer of pollen grains from Polynesian-introduced plants such as *Cocos nucifera* (coconut tree), and unidentified members of the Myrtaceae and Fabaceae families, suggests these introduced plants were at least starting to be established by Hawaiians settling near (inland and possibly adjacent to) this pond during the formation of Layer VIII (tentatively dated to circa A.D. 1275-1425).

This study notes: “The general pattern seen in the pollen recovery that indicates a change in vegetation from a more open habitat to one that recently supported more shrubs and trees...” This is somewhat counter intuitive as the generally understood pattern is that human settlement and use of fire transformed woodlands into grass lands.

It is suggested that this: “can be interpreted as indirect evidence of a cycle of inland erosion and subsequent deposition of sediments in the coastal areas. An increase in sediments in the coastal areas would tend to encourage more plant growth. It is suggested that the availability of such sediments in the inland areas may be linked to traditional agricultural practices in upland forested areas (e.g. slash and bum technique). (Robbins et al. 1999:42)

An inversion in the C14 dates obtained (Robbins et al. 1999:43) suggests the use of caution in detailed interpretation.

### **Athens, Ward and Blinn 2001**

The International Archaeological Research Institute, Inc. (IARII) carried out paleo-environmental coring at a “Tank 2” location in the central portion of the former Hickam Air Force Base (now a part of JBPHH) within what appears to be the former location of Lelepua Fishpond. Six pollen samples from Core 1 were processed. Various inconsistencies in the data led to the conclusion that: “the Tank 2 sediment column consists almost entirely of fill” (Athens et al. 2001:ii) which limits inferences.

### **Dega, Davis, Ward and Winsborough 2002**

In the course of archaeological monitoring and sampling associated with subsurface groundwater plume investigations Scientific Consultant Services carried out a palynological study within the central portion of the former Hickam Air Force Base (now a part of JBPHH) within what appears to be the former location of Ka'ihikapu Fishpond. Four samples from one soil core were analyzed. Significant contamination of the record was indicated as the historically introduced *Batis maritime* pickleweed pollen was “very abundant” in the deepest sample “signaling the presence of historic sediment and organic debris at depth.” (Dega et al. 2002:31)

As “all samples appeared to have experienced mixing” (Dega et al. 2002:32) inferences are limited.

### 8.3.2 Pollen Results from the Present Study

What is desired for pollen studies are ideally deep, stratified, undisturbed, fine sediments in a depositional environment. Most of the pollen studies in the vicinity have targeted the location of former fishponds which, if undisturbed, should be ideal locations for pollen preservation and stratification. This is not what the Airport Section of the HHCTCP corridor offers. The results of the pollen analysis from four of the test excavations are summarized below with a summation of the limited indicated environmental reconstruction following. Pollen samples were taken from natural, relatively-undisturbed sediments. Locations were selected based on field evaluations of the likelihood of sampling locations providing information on former environments. The goal was a modest effort to develop data on prior vegetation and land use given the inherent constraints of the project area.

Table 14. Summary of Pollen Samples

Test Excavation	Provenience	Comment
6	Stratum II, 162-175 cmbs	<i>Myrsine</i> , <i>kōlea</i> , and sedges pollen supports riparian environment
18	Stratum II, 250 cmbs	Relatively dry habitat indicated. Evidence of burning of weeds
22	Stratum II, 150 cmbs and 200 cmbs	Many native shrubs and tree present but also exotic tree pollen, <i>Gossypium</i> -type pollen and <i>Oryza</i> -type pollen
33	Stratum II, 130 cmbs	Relatively dry habitat indicated. <i>Gossypium</i> -type pollen and <i>Oryza</i> -type pollen present.

#### Test Excavation 6 (T-006)

T-006 is located within Kamehameha Highway. The sediments contained cobbles and stones embedded in silty clay loam. Maps indicate this location is very near the former Wailolowai rivulet or water course. Because of safety constraints the bulk sample was carefully recovered with a backhoe bucket. A single sample was submitted for analysis from a depth of 162-175 cm representing Stratum II. The near absence of pollen from this sample, which yielded very small quantities of *Myrsine* and Cyperaceae pollen (Figure 2, Table 2 and 3), representing growth nearby of *kōlea* and sedges, combined with the presence of cobbles and stones indicates that Wailolowai Stream was sampled. Cobbles and stones are indicative of relatively fast moving water. Water that flows swiftly usually carries pollen with it to downstream locations. Only when water slows do the smaller particles, including pollen, drop to the sediments. In this case it is likely that a sedge marsh was located along the banks or in the floodplain of the Wailolowai rivulet and that the water course is represented in the pollen assemblage within the Stratum II sample submitted for pollen analysis.

### Test Excavation 18 (T-018)

T-018 was collected in the sidewalk area of an urban street (Nimitz Highway). A single sample was examined from a depth of approximately 240 cm in Stratum II, representing clay overlying volcanic tuff. Because of safety constraints the bulk sample was carefully recovered with a backhoe bucket. Pollen recovered from this sample was dominated by High-spine Asteraceae pollen, representing an abundance of plants in the sunflower family growing locally. This suggests disturbed sediments as plants of the sunflower family often colonize disturbed soils. Moderate to small quantities of Chenopod and Poaceae pollen were noted in this sample, representing *'aheahea*, which grows in relatively dry habitats, and grasses. Small quantities of *Sida*, *Waltheria*, Liguliflorae, *Boerhavia*-type, Cyperaceae, *Euphorbia*, and *Perispermum* pollen indicate that local vegetation also included *'ilima*, *'ulaloa*, members of the chicory tribe of the sunflower family, *alena*, sedges, spurge, and bonamia. Ferns are well represented in this record. A moderately large quantity of charred Asteraceae fragments and a small quantity of charred Poaceae (grass) fragments were noted suggesting burning weeds, many of which were members of the sunflower family. There is no evidence of agricultural activity in this sample. Total pollen concentration was moderately low at approximately 1260 pollen per cc of sediment.

### Test Excavation 22 (T-022)

T-022 was located within an airport parking lot at Honolulu International Airport. A silty clay loam exhibiting charcoal or black organic stains was present in Stratum II. Two samples were collected with a trowel from depths between 150 and 200 cm. No single pollen taxon dominated the record in either of these samples. Moderately small quantities of Chenopod, *Sida*, High-spine Asteraceae, Liguliflorae, and Poaceae pollen reflect local vegetation that included at least moderate quantities of *'aheahea*, *'ilima*, members of the sunflower family including the chicory tribe, and grasses. A few trees are represented by *Acacia*, *Cocos nucifera*, *Myrsine*, *Pandanus*, and *Pritchardia* pollen indicating local growth of *koa*, coconut, *kōlea*, *hala*, and *loulou* palm. A pore was visible in one of the *Pandanus* pollen, which is necessary to substantiate a distinction between *Pandanus* and *Colocasia* pollen, since they are of similar size and morphology. Additional shrubby vegetation is represented by small quantities of *Broussaisia*, *Hibiscus*, *Plumbago*-type, *Vitex*-type, and *Waltheria* pollen indicating growth of *kanawao*, *hau*, *'ilie'e*, *kolokolo*, and *'uhaloa*. Alien trees are represented by moderate to small quantities of *Leucaena* and *Prosopis* pollen, indicating *koa haole* and *kiawe* growing in the area. Both of these samples contained *Gossypium*-type pollen, suggesting cultivating cotton in the area, possibly in a field at this location. *Gossypium* pollen is noted to travel for several miles on the wind, so locating the agricultural field using *Gossypium* pollen may mean examining many trenches within a transect, if that is desired. Further, large grass pollen, typical of that produced by *Oryza* (rice) was noted in these two samples. It is interesting to note that the upper sample also contained an abundance of burned or charred Poaceae (grass) fragments, suggesting periodic burning of fields that probably contained rice. Both samples also exhibited smaller quantities of Asteraceae charcoal, indicating that members of the sunflower family probably grew as weeds and were burned when the fields were burned. In light of the recovery of *Oryza*-type pollen it is interesting that a wetland signature was not obtained for either of these samples. *Oryza* pollen is smaller in size than *Heteropogon* pollen, although both show a significant amount of surface sculpturing. Moderately large quantities of fern spores were observed in these samples, indicating a

substantial fern population growing in the area. Total pollen concentration was very similar in these two samples at slightly more than 1200 and slightly less than 1300 pollen per cc of sediment in the lower and upper samples, respectively.

### Test Excavation 33 (T-033)

T-033 was excavated within a commercial parking lot on Waiwai Loop revealing silty clay loam with charcoal flecking. One sample from Stratum II, at a depth of 128-139 cm, was collected from T-033. The sample was carefully collected from a small area with a trowel from the cleaned sidewall. The pollen for this sample was dominated by Chenopodiate pollen, probably reflecting primarily *Chenopodium oahuense* ('aheahea). These shrubs prefer drier habitats. Small quantities of *Acacia*, *Anacardiaceae*, *Cocos nucifera*, *Myrtaceae*, *Pittosporum*, and *Pritchardia* pollen were noted, representing trees including *koa*, a member of the sumac family, coconut, a member of the myrtle family, *ho'awa*, and *loulou* palm, suggesting the presence of trees typically associated with a coastal location. Pollen indicating shrubby vegetation includes *Broussaisia* and *Waltheria* in addition to Chenopodiate representing *kanawao* and 'uhaloa. Small quantities of Low-spine Asteraceae, High-spine Asteraceae, Cyperaceae, and *Euphorbia* pollen indicate that members of the sunflower family, sedges, and spurge also grew locally. Small to moderate quantities of *Leucaena* and *Prosopis* pollen represent *koa haole* and *kiawe* growing in this area. Once again *Gossypium* pollen was present, but in a smaller quantity than was observed in Trench 022, possibly indicating that cotton grew farther from this location. This sample also yielded a moderate quantity of *Oryza*-type pollen in spite of the fact that there is no indication in the pollen record of a substantial wetland in this area. Ferns are represented by a few spores. Charred sunflower family fragments were recovered, but charred Poaceae (grass) fragments were not. Total pollen concentration was moderately high at approximately 8500 pollen per cc of sediment, which is more typical of a wetland than a dry deposit.

### 8.3.3 Summary of Pollen Analysis

Regrettably for paleo-environmental reconstruction the Airport Section of the HHCTCP alignment simply lacks good depositional environments as may yield well-stratified pollen records to inform on environmental change over time. A modest effort was made to gain pollen data as may inform on former environments and land use as appropriate for the sampling opportunities present. The only superimposed pollen samples presented here were from T-022 and we are uncertain regarding the time depth indicated. The presence of what appears to be rice (*Oryza*-type) pollen in the lower sample suggests they both may be nearly contemporaneous and historic in age.

The sedge pollen from T-006 supports the inference from the water-rounded tuff pebbles present in the test excavation that flowing water was present in this area. This is also suggested in the Lyons 1873 map (see Figure 11). Other than in this T-006 area, the pollen data is dominated by dryland or mesic species (see Table 15 and Table 16) including several that are well-known and would be expected such as *Sida* ('ilima), *Waltheria* ('uhaloa), and *Vitex* (*pōhinahina*) but also seemingly including *kōlea* (Myrsine), *ho'awa* (*Pittosporum*), *kanawao* (*Broussaisia arguta*), and 'aweoweo (*Chenopodium*).

Table 15. Pollen Taxa Identified from the Airport Section

Scientific Name	Common Name	Nat	Pol	End	Ind
Trees:					
<i>Acacia</i>	<i>Koa, kolu, koai 'e</i>	x		x	
Anacardiaceae	Mango family	x		x	
<i>Cocos nucifera</i>	<i>Coconut, niu, alolani</i>		x		
<i>Myrsine</i>	<i>Myrsine, Ōlika, Kōlea lau nui, Kōlea lau li 'i</i>			x	
Myrtaceae	Myrtle family	x	x	x	x
<i>Pandanus tectorius</i>	<i>Hala, pū hala</i>				x
<i>Pittosporum</i>	<i>Ho 'awa, ha 'awa</i>	x		x	
<i>Pritchardia</i>	<i>Loulu palm, Loulu hiwa</i>			x	
Shrubs:					
<i>Broussaisia arguta</i>	<i>Kanawao, pū 'ahanui</i>			x	
Chenopodium	Goosefoot, pigweed, lamb's quarters, Mexican tea, worm seed, 'aheahea, 'ahea, 'ahewahewa, alaweo, alaweo huna, 'aweoweo, kaha 'iha 'i	x		x	
Cheno-am	Achyranthes, <i>Chenopodium oahuense</i> , Amaranthus, Charpentiera, etc.	x		x	
<i>Cressa</i>	Cressa				x
<i>Euphorbia</i> (shrub or herb)	<i>Kaliko</i> , spurge, Mexican fireplant (wild poinsettia)	x		x	
<i>Hibiscus</i>	<i>Aloalo, hau, koki 'o, ke 'oke 'o, (hau hele, koki 'o kea, pamakani), ma 'o hau hele, kaiohala (akiahala, hau hele wai), koki 'o (mākū), large leaved hau, cotton or confederate rose (aloalo waikāhuli, waikāhuli)</i>	x		x	x

Scientific Name	Common Name	Nat	Pol	End	Ind
<i>Plumbago</i>	<i>Ilie'e, hilie'e</i>				x
<i>Sida</i>	<i>'ilima</i> , Prickly sida	x			x
<i>Vitex</i>	<i>Kolokolo kahakai, hinahina kolo, mānawanawa, māwanawana, pōhinahina, pōlinalina</i> , beach vitex				x
<i>Waltheria</i>	<i>'Uhaloa ('ala'ala pū loa)</i>				x?
Herbs:					
Low-spine Asteraceae	Sunflower family; includes ragweed and others	x		x	x
High-spine Asteraceae	Sunflower family; includes <i>Bidens</i>	x		x	x
Liguliflorae	Sunflower family, chicory tribe	x			
Boerhavia	<i>Alena, anena, nena</i>	x			x
<i>Bonamia menziesii</i> ( <i>Perispermum</i> )	None (Vine in dry to mesic forest)			x	
Cleome	Spider plant, spider flower, spider wisp, <i>honohina</i> , <i>'ili'ohu</i> , <i>honohino</i>	x			x?
<i>Polygonum</i> sp.	Knotweed/smartweed	x			
<i>Stenogyne</i>	<i>Pua'ainaka, Ma'ohi'ohi, Mohini</i>			x	
Grasses, etc.:					
Cyperaceae	Sedge family	x		x	x
Poaceae	Grass family	x		x	x
<i>Typha</i>	Cattail	x			
Cultigens:					
<i>Gossypium tomentosum</i>	<i>Ma'o, huluhulu</i> , native cotton			x	
<i>Oryza</i>	Rice	x			
<i>Vigna</i>	<i>Mohihihi, nanea</i> , beach pea			x	x
Aliens:					

Scientific Name	Common Name	Nat	Pol	End	Ind
<i>Leucaena</i>	<i>Koa-haole ('ekoa, lilikoa)</i>	x			
<i>Prosopis</i>	<i>Kiawe, mesquite</i>	x			
Indeterminate	Too badly deteriorated to identify				
Spores:					
Dicksoniaceae	Tree fern family			x	x
<i>Lycopodium cernuum</i>	Club moss ( <i>Wiwae'iole</i> )			x	
Monolete	Fern				
Trilete	Fern				
Other:					
Starch angular	Grass seed-type starch				
Foraminifera	Forams				
Scolecodont	Polychaet worm jaw				
Microscopic charcoal	Microscopic charcoal				
Charred Asteraceae fragments	Charred pieces of a member of the sunflower family				
Charred Poaceae fragments	Charred pieces of grass				

Plant names and information derived from (Wagner et al. 1990)

Fern (spore) names derived from (Selling 1946)

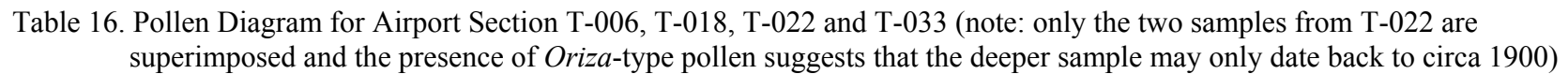
Nat = Naturalized (Adapted to a new environment and established as if native)

Pol = Polynesian introduction (Introduced to Hawai'i by Polynesian voyagers)

End = Endemic (Evolved in Hawai'i, found only in these islands)

Ind = Indigenous (Found natural in Hawaii but elsewhere as well)

Pollen identifications to species were based when only 1 species is reported by (Wagner et al. 1990). Species identification was not made based solely on morphologic characteristics observed under the microscope.



Several relatively drought tolerant trees are indicated in the pollen record including *Pandanus tectorius* (hala), *Acacia* (koai'e) and *Pritchardia* (loulou). Such pollen could have easily drifted south on the prevailing tradewinds and it remains unclear if they reflect a local community or a community significantly upwind. Macdonald et al. (1983:446), noting the presence of loulou palms and tree ferns buried standing up in air laid Salt Lake tuff, concluded that "the local climate at the time of the eruption was considerably wetter than it is now." The uncertain time depth represented by the pollen and the dynamic environment add to the uncertainties but it does seem likely that a significantly more diverse plant community was present previously than modern conditions would suggest.

The only Polynesian introduction indicated is coconut (*niu*, *Cocos nucifera*). Post-contact introductions indicated included:

- *Leucaena*
- *Prosopis*
- *Gossypium*, and
- *Oryza*-type pollen

The identification of *Oryza*-type pollen in T-022 and T-033 and of an "abundance of burned or charred Poaceae (grass) fragments, suggesting periodic burning of fields that probably contained rice" is noteworthy. Coulter (1937:21; see Table 17 and Figure 248) asserts that in 1892 there were 117 acres of Hālawā under rice cultivation and perhaps similar acreage under rice in Moanalua Ahupua'a (the joint estimate of 150 acres in rice for Moanalua and Kalihi is given). Coulter (1937:20) cites Damon in an article in *The Friend* in 1882 as relating that "on Oahu the rice plantations began a few miles west of Honolulu and formed a fringe bordering the shore for a long distance ... Every available inch of ground seemed to be utilized" The burning of dried rice paddies after harvest could have led to the broadcasting of rice pollen on the trade winds.

Table 17. Rice Farming Districts on O'ahu, 1892 (Acres) (from Coulter 1937:21)

TABLE III Rice Farming Districts on Oahu, 1892			
	Acres		Acres
Aiea and Kalauao	76	Mokuleia and vicinity	738
<b>Halawa</b>	117	Palama	200
Hauula	25	Palolo	102
Heeia and Kaneohe	200	Punaluu and vicinity	300
Honouliuli, etc.	147	Waialae	32
Kaalaea and Kahaluu	300	Waialua	180
Kahuku	50	Waiau, Manana and Waiawa	262
Kailua and Waimanalo	400	Waikane and vicinity	200
<b>Kalihi and Moanalua</b>	150	Waikēle and Waipio	333
Kewalo and vicinity	75	Waikiki	542
Laie	45	Waimalu	135
		Other places	50
			<b>4,659</b>



Figure 248. Portion of Coulter's (1937:12) map of "Rice Farming Districts on Oahu 1892"

(Note: indications of rice cultivation in coastal Hālawā and a wide swath of Moanalua

Cummings (2012:4; see Appendix F-3) notes the presence of “Gossypium-type pollen” in Test Excavations 22 and 33 “suggesting cultivating cotton in the area.”

The simplest explanation for the relative abundance of “Gossypium-type pollen” is that it is from the native *Ma‘o* (*Gossypium tomentosum*), a wide-branched shrub that endures today as one of the most prominent large native shrubs to survive on the dry, southern coastal plain of O‘ahu. *Ma‘o* may well have been particularly abundant in the environs of the Airport Section project area for millennia uncounted.

Cotton was, however, an experimental industry of the Kingdom of Hawaii with Kamehameha I signing a contract regarding cotton exports in 1812 (Kuykendall Vol. I 1968:86). In 1835, cotton cultivation was first on the list of missionary's efforts to encourage "the development of industrious habits among the people...They pointed out that cotton grew well and that cotton cloth was in high demand among the people having nearly supplanted kapa for clothing." (Kuykendall Vol. I 1968:174) Around 1831/1832, William French and a Mr. Reid sought "to hire a tract of land inland of the district of Ewa, Oahu. Their object was to cultivate cotton..." (Kuykendall Vol. I 1968:174). There was a resurgence of cotton cultivation in Hawai'i during the trade disruptions of the American Civil War. "In the summer of 1861, Judge John Ii traveled over the islands distributing cotton seed (of the common variety) and induced many Hawaiians to try raising cotton." (Kuykendall Vol. II 1982:174). Cotton was exported from the Kingdom through the period 1863-1874. John Papa 'Ī'ī was much associated with downtown Honolulu and his "Mililani" home (on Mililani Street) from whence he would often journey to his estates in Waipi'o Ahupua'a of 'Ewa (modern Mililani being in the uplands of Waipi'o). Each journey would have transited Moanalua and Hālawā twice. It would thus seem surprising if John Papa 'Ī'ī did not distribute cotton seed and induce Hawaiians to try raising cotton in Moanalua and Hālawā in 1861. Given 'Ī'ī's enthusiasm for cotton cultivation and his association with enterprise in the general region and the account of an earlier effort to pursue growing cotton in 'Ewa (circa 1831/1832) we would not discount the possibility of "cultivating cotton in the area."

## 8.4 Charcoal Species Identification

The charcoal assemblage recovered from the Airport Section 3 test excavations was quite modest (see Table 18). The sample that was regarded as the best was sent to Ms. Gail Murakami at the International Archaeological Research Institute, Inc for species identification. The purpose of the charcoal taxa identification was to aid in the selection of charcoal from relatively short-lived species prior to sending out the sample for carbon dating to avoid an inappropriately old date from the dating of "old wood." A charcoal sample was identified as from the native Hawaiian tree *Uhiuhi* (*Caesalpinia kawaiensis*) (Table 19 and Figure 249).

Table 18 Charcoal Sample Table

Trench #	Stratum	Depth (cmbs)	Weight (g)
T-018	II	240	<0.1
T-031*	Id	23-26	0.5
T-032	Ila	89-107	<0.1
T-038	II	259-269	1.4
T-041	II	138-143	0.5

\*charcoal sample identified as to taxa and submitted for carbon dating

Table 19. Charcoal Taxa Identification in Samples from the Honolulu High-Capacity Transit Corridor Project, O'ahu Island.

Provenience	WIDL No.	Taxa	Common/Hawaiian Name	Origin/Habit	Part	Count	Weight g
T-031, Ualena Street, west of Lagoon Drive, in parking lot on <i>makai</i> side	1302-1	<i>Caesalpinia kawaiensis</i>	<i>Uhiuhi</i>	Native/Shrub-Tree	Wood	15	0.5

*Uhiuhi* is a shrub or tree (4 to 10 m tall, Figure 249) associated with dry forest or mesic forest at an elevation of 80-920 m. Early Hawaiians made spears with the wood as well as a fishing implement known as *lā'au melomelo* or *lā'au mākālei* (Wagner et al. 1990:648). Fewer than fifty individual trees are known today (Wagner et al. 1990:648).



Figure 249. *Uhiuhi* (*Caesalpinia kavaensis*), an endemic Hawaiian forest tree

## 8.5 Carbon 14 Dating

Only five small fractions of charcoal were recovered (see Table 18) and none of the samples were regarded as from discrete features or other particularly good provenience. A sample from T-031, on Ualena Street, west of Lagoon Drive, in a parking lot on the *makai* side was sent for charcoal speciation and appeared promising as an endemic species (*Uhiuhi*, *Caesalpinia kavaensis*), was indicated. Furthermore the fact that the tree is associated with higher elevations suggested that the wood was possibly brought down to the coast for one of the indicated possible fishing uses as a spear or as a bait stick.

A relatively wide date range was recovered (Table 20) with multiple peak expressions (Figure 250). The charcoal may have been produced in late pre-Contact times (as early as AD 1660 but could have dated to as late as the early twentieth century. Given the great rarity of the tree today a date earlier in the range is suggested – but little can be said with certainty.

Table 20. Results of AMS radiocarbon dating

CSH ID #	Beta Analytic ID #	Sample Material/ Analytic Technique	Provenience	Conventional Radiocarbon Age	C13/C12 Ratio	OxCal Calibrated Calendar Age (2 sigma)
H13T-031Id	Beta 342817	Charred wood material	T-031, Stratum Id 22-26 cmbs	140 +/-30 BP	-24.5 ‰	1660 – 1950 AD

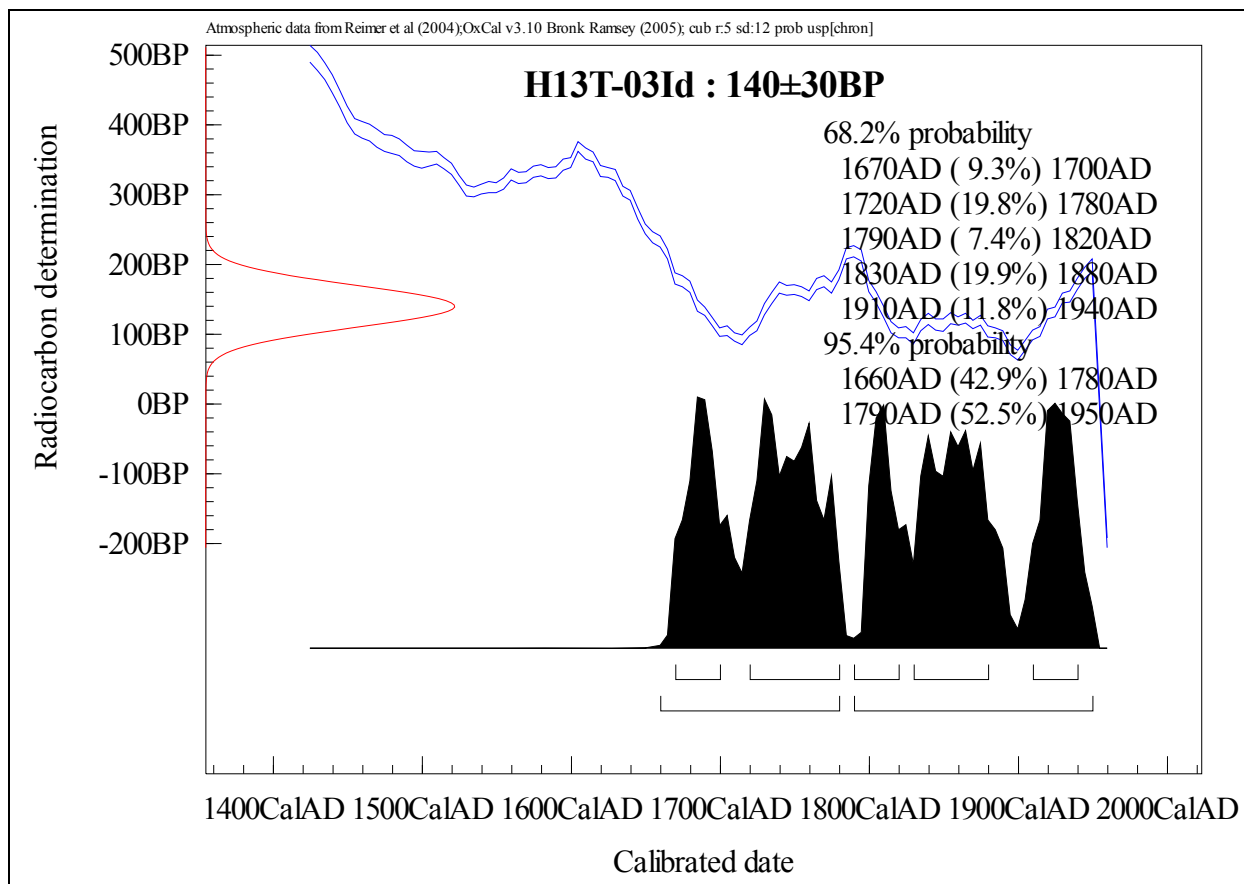


Figure 250. C14 Sample calibrated date graph for T-031 (Stratum Id 22-26 cmbs) *Uhiuhi* (*Caesalpinia kavaensis*) charcoal